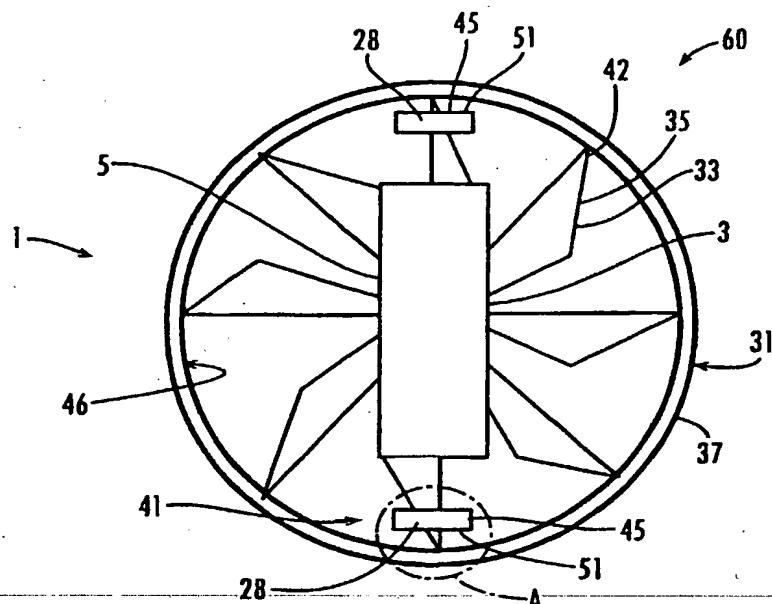
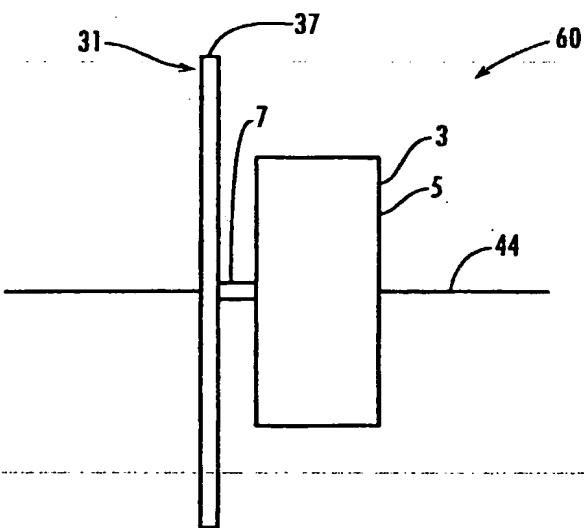


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*Fig. 1*

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*Fig. 2*

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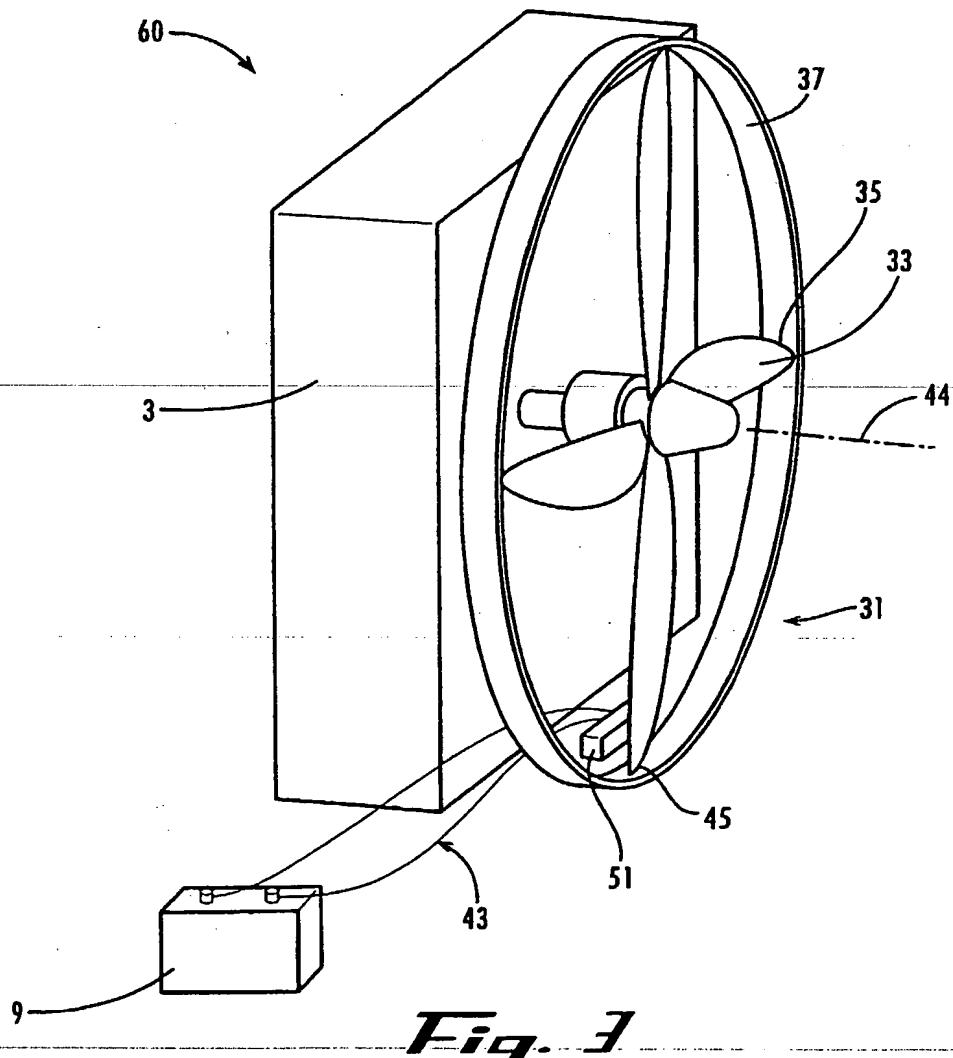


Fig. 3

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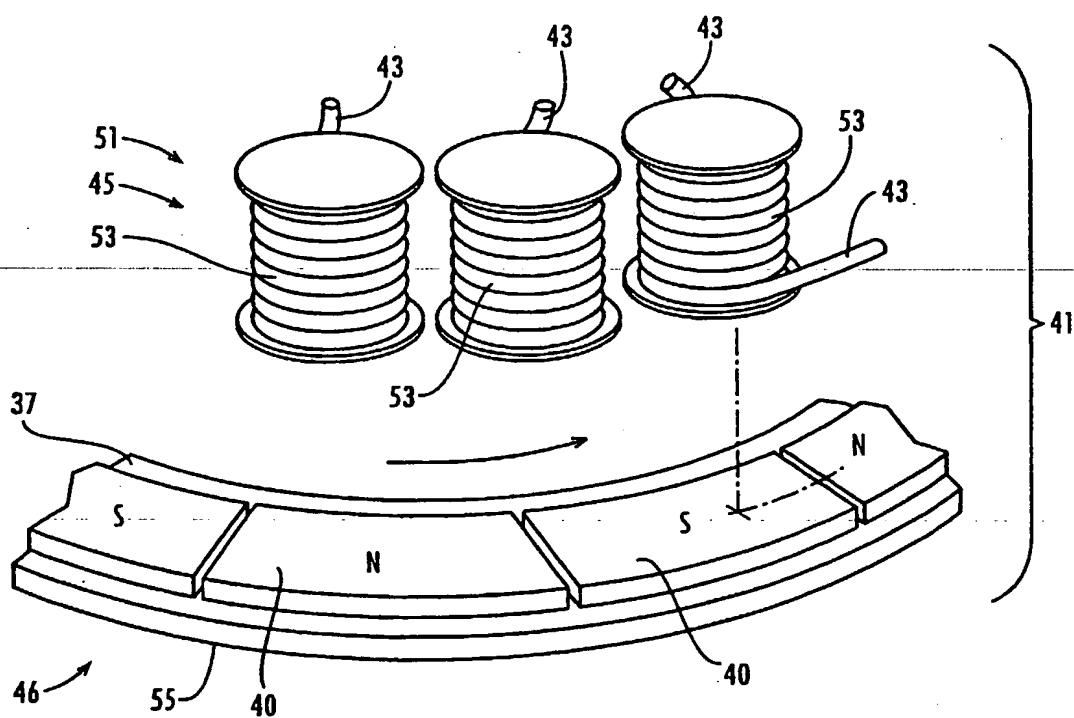


Fig. 4

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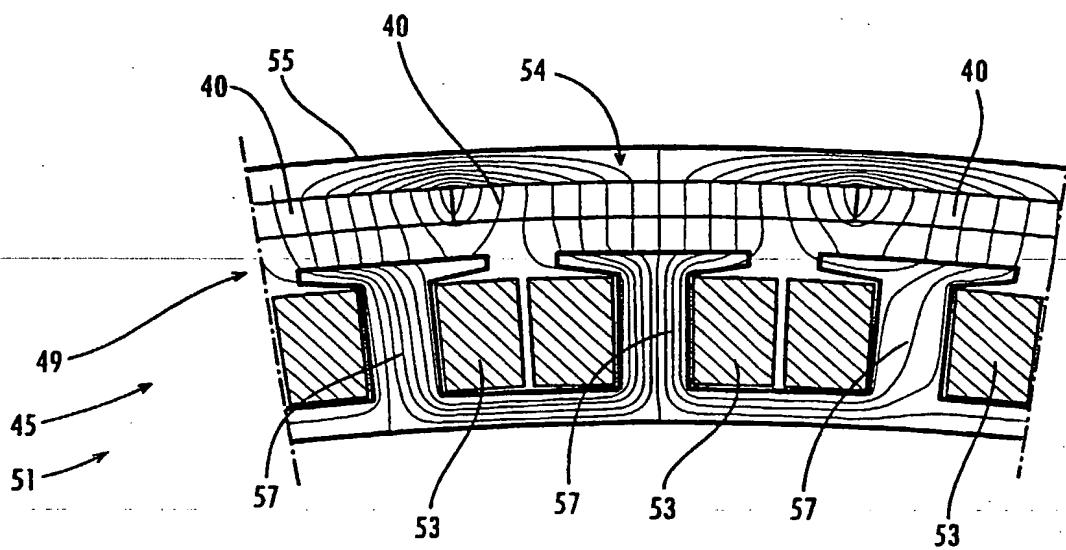


Fig. 5

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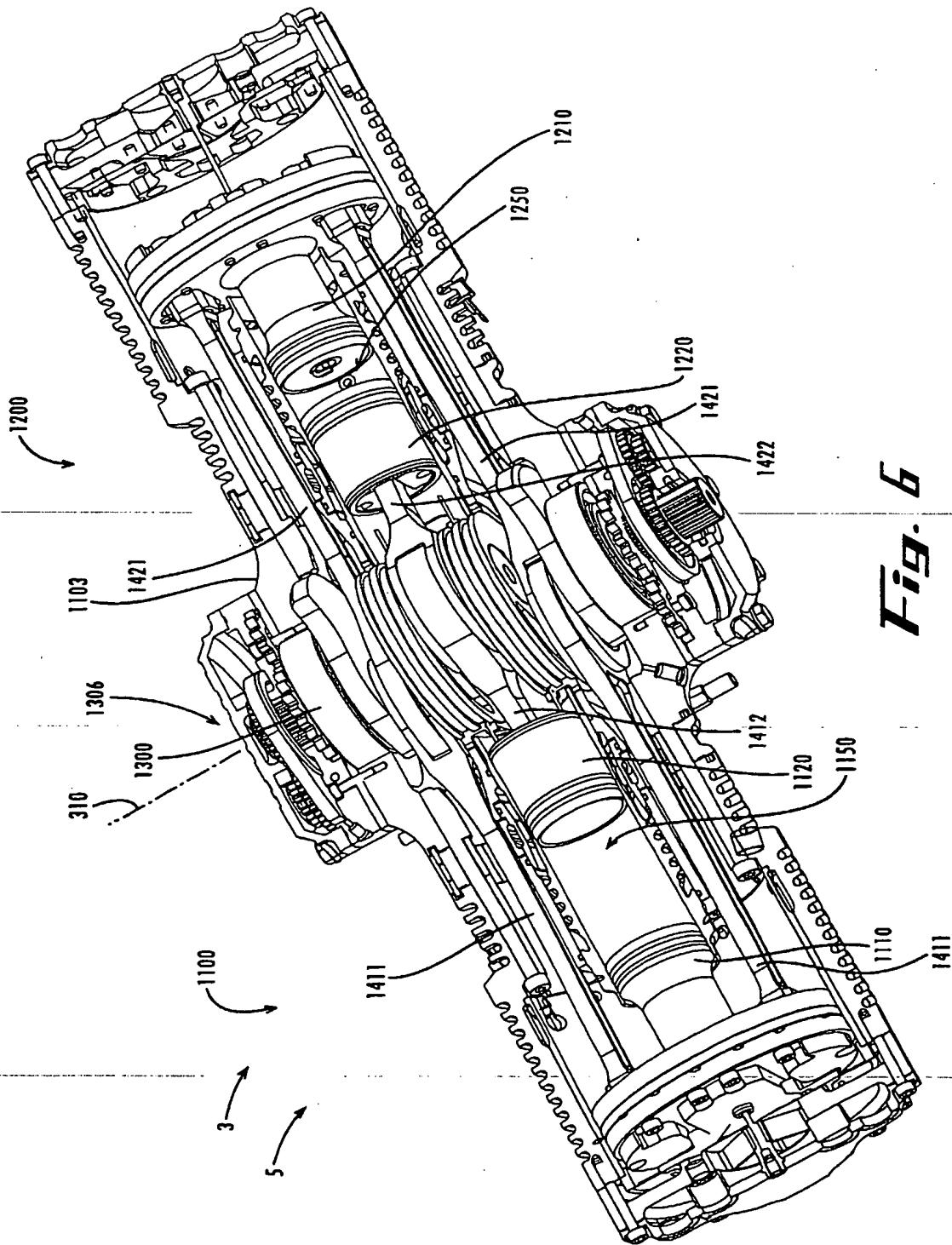


Fig. 6

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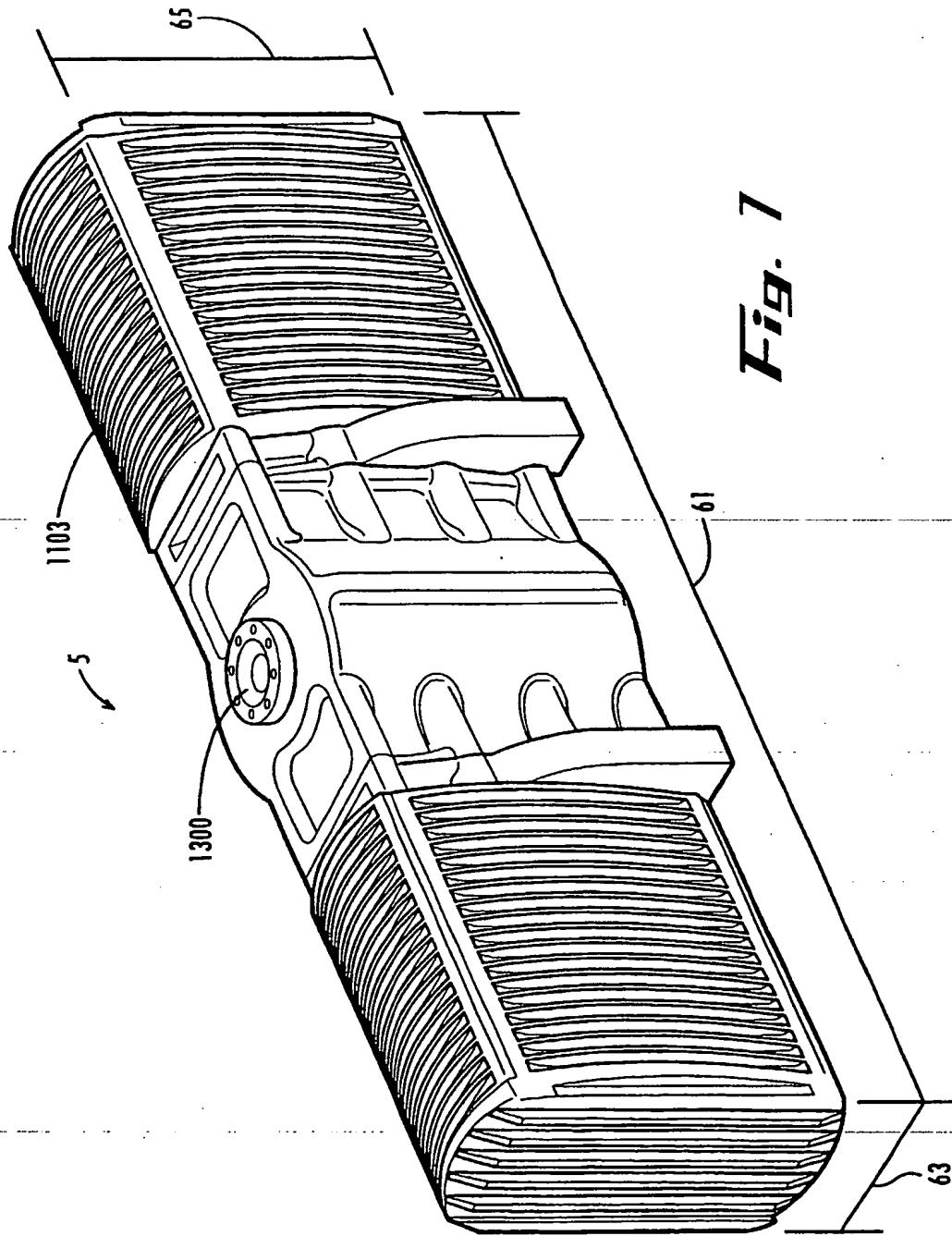


Fig. 7

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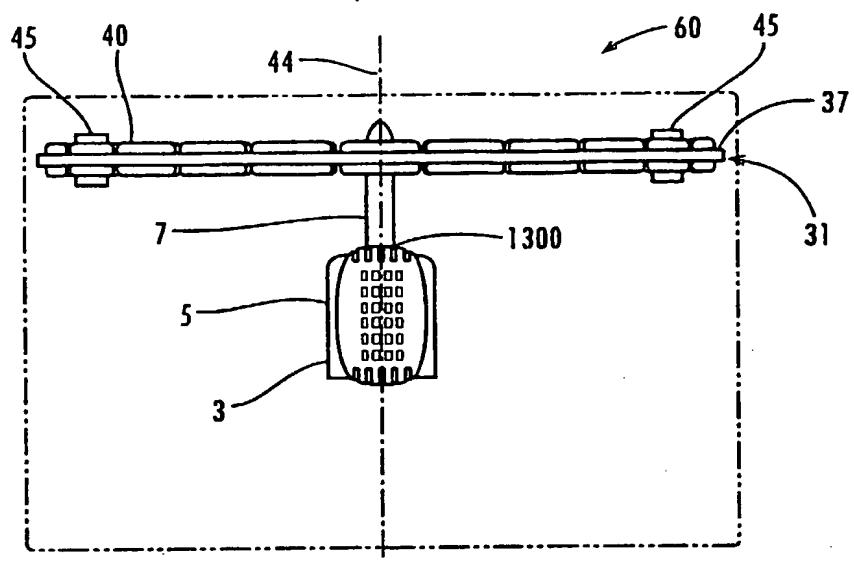


Fig. 8A

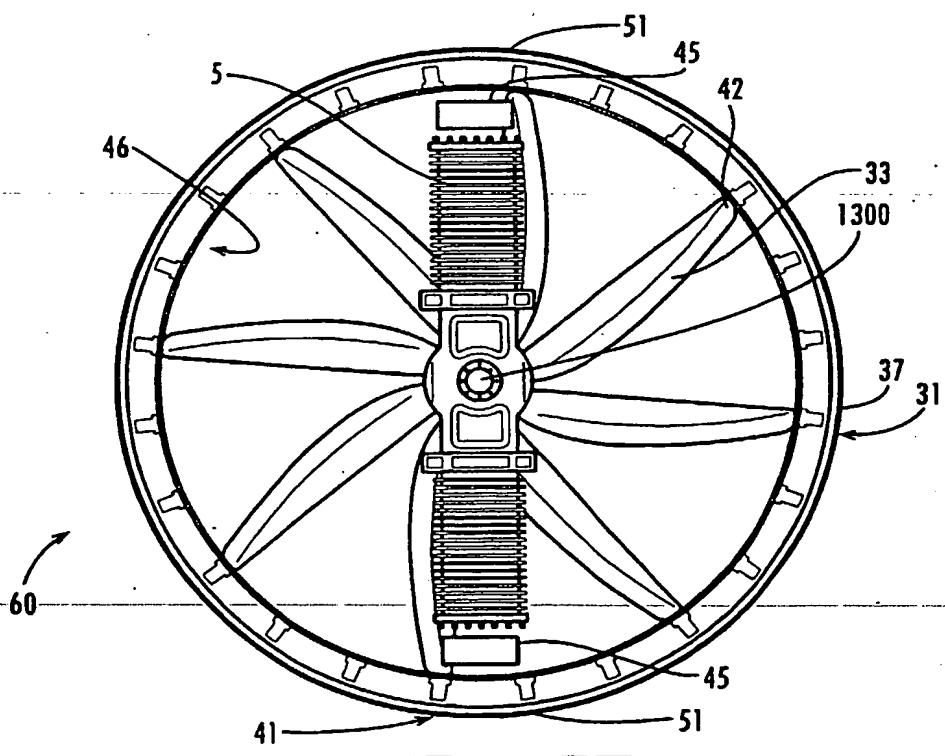
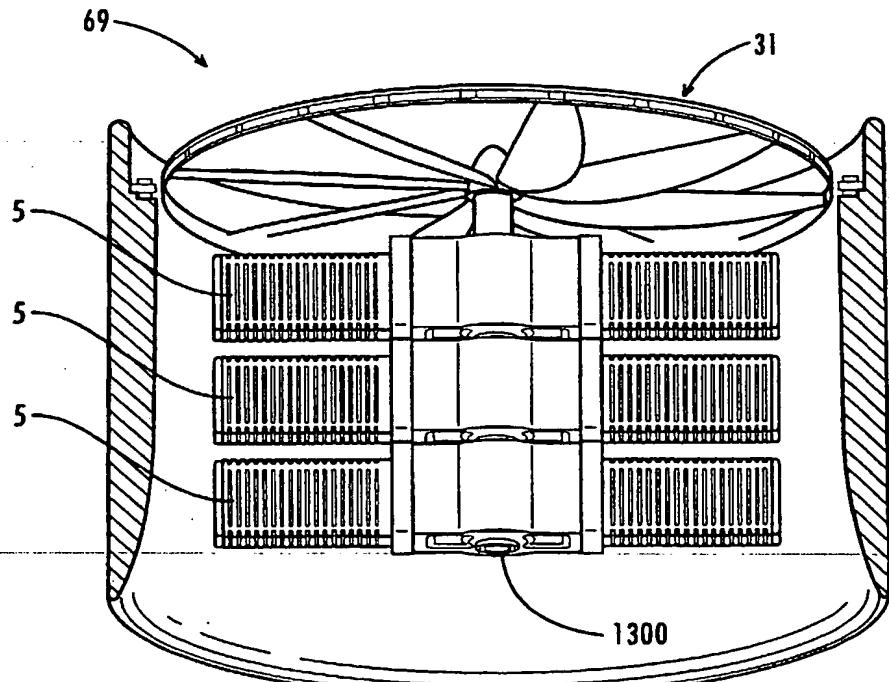
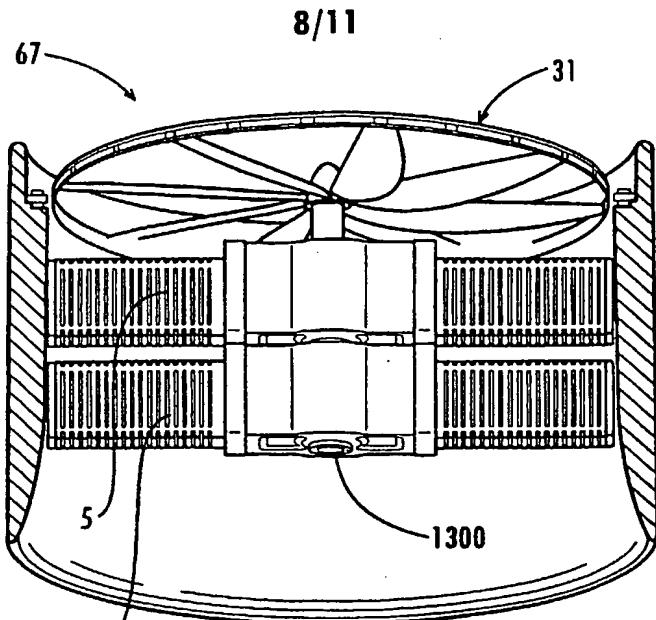


Fig. 8B

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Engine Design Input Data

| | | | |
|---|--------|------|-----|
| Cylinder Bore | B | 32 | mm |
| Engine Stroke | S | 60 | mm |
| Conrod Length | L | 50 | mm |
| Engine Speed | N | 9182 | rpm |
| Compression Ratio | CR | 19 | |
| Intake/Boost Pressure (abs) | Pi | 0.9 | bar |
| Intake/Boost Temperature | Ti | 20 | C |
| Fuel (D for diesel, G gasoline, M methanol) | | d | |
| Stroke (FOUR for 4 stroke, TWO 2 stroke) | | two | |
| Relative Air/Fuel ratio | Lambda | 1.5 | |
| Number of Cylinders | n | 2 | |

Estimated Engine Performance Data

| | | | |
|----------------------------------|-------|------|-----|
| Cylinder Peak Pressure | Pmax | 66 | bar |
| Peak Pressure Phase (ATDC) | Alpha | 5 | deg |
| Break Mean Effective Pressure | BMEP | 4.52 | bar |
| Engine Power at the Given Speed | P | 9.0 | hp |
| Engine Torque at the Given Speed | T | 6.9 | Nm |

Fig. 10

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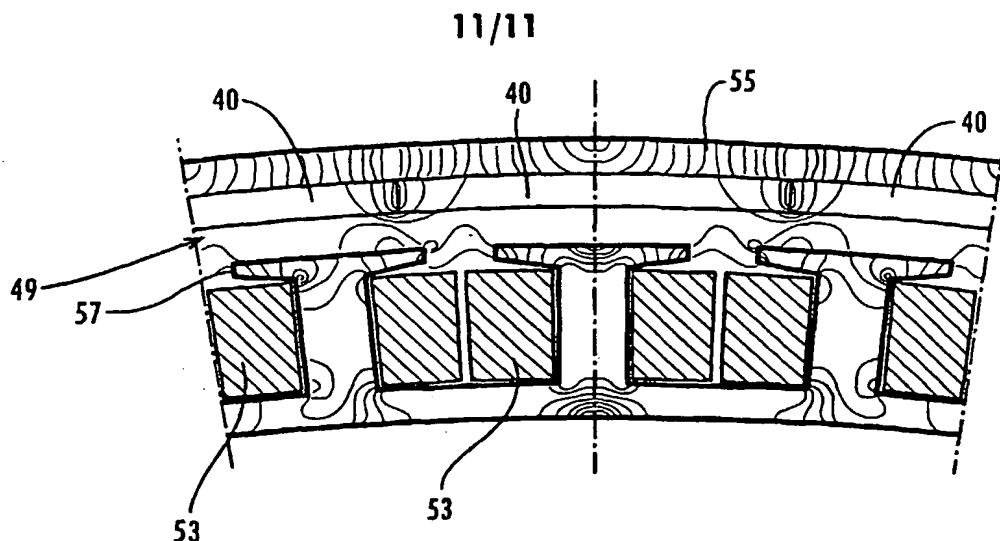
| FAMILY 1a (two cylinder unit = opoc module, two gear-set) | | | | | | | | | | | | | |
|---|------|-------|-------|---------------|------|-------|------|-------------|------|-------|-----------|-----|------------------------|
| Cyl. | Mach | Speed | MPS | Piston Stroke | | Power | | opoc Weight | | BSFC | | Eff | Transmission |
| Nr. | Nr. | rpm | n/sec | cm | in | hp | kW | g | lbs | g/kWh | lbs/hp-hr | % | Planetary Transmission |
| 2 | 0.85 | 12500 | 11.0 | 2.64 | 1.04 | 9 | 6.7 | 1825 | 4.0 | 500 | 0.822 | 17% | Direct drive |
| 4 | 0.85 | 12500 | 11.0 | 2.64 | 1.04 | 17 | 12.7 | 3950 | 8.7 | 480 | 0.789 | 18% | Gear ratio: 1 = 0.66 |
| 6 | 0.85 | 12500 | 11.0 | 2.64 | 1.04 | 42 | 31.3 | 7743 | 17.1 | 430 | 0.707 | 20% | Gear ratio: 1 = 0.39 |

| FAMILY 1b (only one standardized one cylinder unit = opoc module, but three gear-set) | | | | | | | | | | | | | |
|---|-------|-------|-------|---------------|------|-------|------|-------------|------|-------|-----------|-----|----------------------|
| Cyl. | Mach | Speed | MPS | Piston Stroke | | Power | | opoc Weight | | BSFC | | Eff | Transmission |
| Nr. | Nr. | rpm | n/sec | cm | in | hp | kW | g | lbs | g/kWh | lbs/hp-hr | % | |
| 2 | 0.68 | 10000 | 10.0 | 3.00 | 1.18 | 9 | 6.7 | 3150 | 6.9 | 450 | 0.740 | 19% | Direct drive 1.2 |
| 4 | 0.68 | 10000 | 10.0 | 3.00 | 1.18 | 17 | 12.7 | 6350 | 14.0 | 430 | 0.707 | 20% | Gear ratio: 1 = 2.08 |
| 6 | 0.748 | 11000 | 11.0 | 3.00 | 1.18 | 42 | 31.3 | 9550 | 21.1 | 400 | 0.658 | 21% | Gear ratio: 1 = 0.45 |

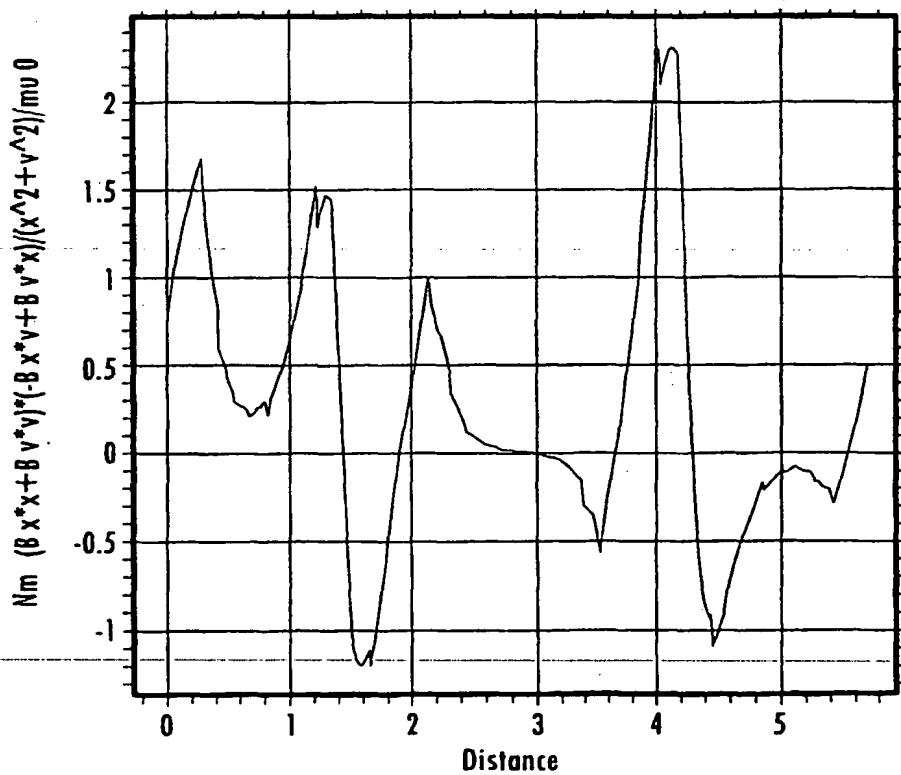
| FAMILY 2 (two cylinder units = opoc modules, one gear-set, no 6 cylinder) | | | | | | | | | | | | | |
|---|------|-------|-------|---------------|------|-------|------|-------------|------|-------|-----------|-----|----------------------|
| Cyl. | Mach | Speed | MPS | Piston Stroke | | Power | | opoc Weight | | BSFC | | Eff | Transmission |
| Nr. | Nr. | rpm | n/sec | cm | in | hp | kW | g | lbs | g/kWh | lbs/hp-hr | % | |
| 2 | 0.85 | 12500 | 11.0 | 2.64 | 1.04 | 9 | 6.7 | 1825 | 4.0 | 500 | 0.822 | 17% | Direct drive |
| 2 | 0.85 | 8300 | 11.0 | 3.98 | 1.57 | 17 | 12.7 | 5125 | 11.3 | 400 | 0.658 | 21% | Direct drive |
| 4 | 0.85 | 8300 | 11.0 | 3.98 | 1.57 | 42 | 31.3 | 10600 | 23.4 | 380 | 0.625 | 23% | Gear ratio: 1 = 0.59 |

| FAMILY 3 (three cylinder units = opoc modules, all direct drive and 2 cylinders) | | | | | | | | | | | | | |
|--|------|-------|-------|---------------|------|-------|------|-------------|------|-------|-----------|-----|--------------|
| Cyl. | Mach | Speed | MPS | Piston Stroke | | Power | | opoc Weight | | BSFC | | Eff | |
| Nr. | Nr. | rpm | n/sec | cm | in | hp | kW | g | lbs | g/kWh | lbs/hp-hr | % | |
| 2 | 0.85 | 12500 | 11.0 | 2.64 | 1.04 | 9 | 6.7 | 1825 | 4.0 | 500 | 0.822 | 17% | Direct drive |
| 2 | 0.85 | 8300 | 11.0 | 3.98 | 1.57 | 17 | 12.7 | 5125 | 11.3 | 400 | 0.658 | 21% | Direct drive |
| 2 | 0.85 | 4900 | 11.0 | 6.73 | 2.65 | 42 | 31.3 | 24950 | 55.0 | 340 | 0.559 | 25% | Direct drive |

Fig. 11

*Fig. 12*

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*Fig. 13*